



Analysis of Factors Associated with Dental Caries Among Students

Yuniarti¹, Ali Harokan¹, Lilis Suryani¹

¹Faculty of Public Health, STIK Bina Husada, Palembang, Indonesia

*Corresponding Author: Yuniarti

E-mail: yuyunrey18@gmail.com



Article Info

Article history:

Received 18 August 2026

Received in revised form 20
September 2026

Accepted 11 October 2026

Keywords:

Dental Caries

Oral Hygiene

Cariogenic Food

Fluoride

School Dental Health

Program (UKGS)

Abstract

Dental caries remains a common oral health problem among school-age children. The occurrence of caries is influenced by various factors, including the consumption of cariogenic foods, oral hygiene, fluoride use, and individual and socioeconomic characteristics. This study aimed to analyze the factors associated with the incidence of dental caries among students of SMP Negeri 1 Tanjung Lubuk in the working area of Pengarayan Public Health Center, Ogan Komering Ilir Regency, in 2026. This study employed a quantitative design with a cross-sectional approach. The sample consisted of 96 respondents selected using a purposive sampling technique. Data were analyzed using the Chi-Square test and multiple logistic regression. The results showed that 44.8% of respondents had dental caries, while 55.2% did not. There were significant associations between the consumption of cariogenic foods ($PR = 0.429$), oral hygiene/toothbrushing behavior ($PR = 6.857$), and fluoride use ($PR = 0.353$) with the incidence of dental caries. No significant associations were found between age, sex, and socioeconomic status with the incidence of dental caries. Multivariate analysis showed that oral hygiene was the most dominant factor associated with the incidence of dental caries ($OR = 42.000$). This study concludes that oral hygiene is the primary factor associated with the incidence of dental caries among students of SMP Negeri 1 Tanjung Lubuk. Strengthening promotive and preventive efforts through the School Dental Health Program (UKGS), education on proper toothbrushing, fluoride use, and control of cariogenic food consumption is needed.

Introduction

Dental caries remains a significant public health concern affecting children and adolescents worldwide. This condition develops through complex interactions between oral microorganisms, fermentable carbohydrates, individual susceptibility, and preventive oral health practices. Untreated dental caries may cause persistent pain, difficulty eating, sleep disturbances, and reduced quality of life, potentially interfering with children's educational participation and daily activities. Botelho-Filho et al. (2025), in a systematic review and meta-analysis, demonstrated that dental caries negatively affects adolescents' daily activities, emphasizing the broader consequences of poor oral health beyond clinical symptoms. Similarly, Chou et al. (2023) highlighted the importance of preventive dental interventions among school-aged children and adolescents, particularly through appropriate fluoride application and other evidence-based preventive measures. These findings indicate that dental caries prevention should remain an important priority in school health programs.

The burden of dental caries is particularly concerning in developing countries, where differences in oral health awareness, preventive practices, and access to dental healthcare may contribute to persistent oral health problems. In Indonesia, dental caries continues to affect a considerable proportion of school-aged children despite ongoing oral health promotion activities. Sainuddin et al. (2023), in a study involving Indonesian elementary school students, identified significant associations between dental caries and oral health knowledge, toothbrushing habits, and cariogenic food consumption. These findings suggest that improving preventive behavior is essential for reducing dental caries among school-aged populations. However, the occurrence of dental caries may differ across schools and communities, making locally focused investigations important for understanding specific contributing factors.

Dietary habits are among the most important modifiable factors associated with dental caries. Frequent consumption of sugary foods and beverages provides fermentable carbohydrates that oral microorganisms convert into acids, contributing to enamel demineralization. Pombo-Lopes et al. (2026), in a systematic review involving 37 studies and 59,383 participants, reported consistent associations between sugar consumption and dental caries among children and adolescents, particularly concerning the frequency of sugar exposure. Cascaes et al. (2023) also demonstrated that ultra-processed food consumption was associated with dental caries among younger populations. Furthermore, Large et al. (2024) emphasized the importance of unhealthy food and beverage consumption as a dietary factor associated with dental caries in children. These findings support the need to examine cariogenic food consumption among adolescents, particularly during a developmental period characterized by increasing independence in food selection.

In addition to dietary habits, the use of sugar substitutes has been explored as an alternative approach to dental caries prevention. Luo et al. (2024), in a systematic review and meta-analysis, found that xylitol and sorbitol may contribute to preventing dental caries in permanent teeth among children and adolescents, although the included studies varied in methodological quality. These findings suggest that dietary modification can support oral health prevention when combined with appropriate oral hygiene practices. Nevertheless, dietary behavior should be evaluated comprehensively because the frequency, type, and duration of exposure to cariogenic foods may influence dental health differently.

Oral hygiene practices, particularly regular and appropriate toothbrushing, play an essential role in preventing dental caries. Inadequate toothbrushing may result in prolonged dental plaque accumulation, increasing exposure to acids produced by oral bacteria. Oral hygiene behavior is influenced not only by individual knowledge but also by daily routines, parental supervision, and access to oral healthcare products. Adolescents may understand the importance of toothbrushing but fail to maintain appropriate brushing frequency and technique consistently. Therefore, investigating oral hygiene practices is necessary to understand their association with dental caries and identify opportunities for improving preventive behavior among school students.

Fluoride use represents another important component of dental caries prevention because fluoride helps promote enamel remineralization and reduce demineralization. Dhanapriyanka et al. (2024), in a systematic review involving studies from low- and middle-income countries, found that professionally applied fluoride interventions, including fluoride varnish and gel, could contribute to caries prevention, although effectiveness varied according to the intervention and type of dentition. These findings emphasize the importance of appropriate fluoride exposure in maintaining dental health. However, individual fluoride use may differ according to product availability, oral hygiene practices, parental awareness, and access to preventive dental services. Consequently, examining fluoride use among school students may provide useful information regarding differences in preventive oral health behavior.

Socioeconomic conditions may also influence dental caries through differences in household resources, access to oral healthcare services, dietary choices, and preventive health practices. Sabbagh et al. (2023), in a systematic review and meta-analysis, examined the relationship between food insecurity and dental caries among children and adolescents, highlighting the importance of nutritional and socioeconomic vulnerability. Similarly, Fadila et al. (2024) identified associations between family socioeconomic and demographic characteristics and several aspects of children's oral health, including preventive practices and dental healthcare utilization. Almajed et al. (2024) further explained that socioeconomic disadvantage contributes to inequalities in pediatric oral health through barriers to dental services and preventive resources. These findings indicate that socioeconomic status should be considered alongside individual oral hygiene and dietary behaviors when investigating dental caries.

The relationship between socioeconomic circumstances and dental caries may also be influenced by family education and household income. Dewi et al. (2024), through a meta-analysis, investigated the associations of sugar consumption, household income, and maternal education with dental caries in children. Their findings reinforce the importance of examining both behavioral and socioeconomic determinants. Furthermore, demographic characteristics such as age and sex may influence oral health through differences in dental development, personal hygiene behavior, and dietary patterns. Mazur et al. (2023), in a systematic review and meta-analysis, identified an association between molar-incisor hypomineralization and dental caries among children, illustrating the contribution of developmental dental conditions to caries susceptibility. Although the present study does not examine enamel developmental defects, these findings highlight the complexity of dental caries and the need to interpret demographic associations within the broader context of individual susceptibility and preventive behavior.

School-based oral health promotion provides an important opportunity to reduce dental caries through education, preventive interventions, and improved access to oral healthcare. Ghasemi et al. (2025), in a cluster-randomized controlled trial involving Iraqi schoolchildren, evaluated a school-based oral health promotion program that combined oral health education with fluoride varnish application. Their study demonstrated the importance of implementing structured preventive interventions in educational settings. Additionally, Nath et al. (2023), in a systematic review and meta-analysis examining dental caries among racially minoritized children, highlighted disparities in oral health outcomes across population groups. These findings suggest that effective school-based prevention should consider both individual behaviors and broader social inequalities to ensure that preventive services reach children with different levels of oral health risk.

At the local level, dental caries remains an important health concern in the working area of Pengarayan Public Health Center, Ogan Komering Ilir Regency, South Sumatra. Based on secondary service records reported by Pengarayan Public Health Center, the number of dental caries cases among school-aged children increased from 281 cases in 2023 to 290 cases in 2024 and 460 cases in 2025. Approximately 125 cases recorded in 2025 originated from SMP Negeri 1 Tanjung Lubuk, indicating a substantial burden of dental caries within this school population. These figures suggest the need for further investigation into the factors associated with dental caries among students. However, these data represent reported healthcare service cases rather than population-based prevalence estimates and should therefore be interpreted within the context of routine health service reporting.

Although previous studies have examined behavioral, demographic, and socioeconomic factors associated with dental caries, their relationships may differ depending on the characteristics of school populations, local health services, and individual preventive practices. Evidence specifically addressing these factors among students of SMP Negeri 1 Tanjung Lubuk remains limited. Moreover, examining multiple factors within the same school population may help

identify which characteristics are most strongly associated with dental caries in this particular setting. Therefore, this study aimed to analyze the associations of age, sex, cariogenic food consumption, oral hygiene, fluoride use, and socioeconomic status with dental caries among students of SMP Negeri 1 Tanjung Lubuk in the working area of Pengarayan Public Health Center, Ogan Komering Ilir Regency, in 2026. The findings are expected to provide evidence for strengthening promotive and preventive oral healthcare activities through the School Dental Health Program (UKGS) and improving targeted oral health education among adolescents.

Methods

Study Design

This study was a quantitative study employing an observational analytic design with a cross-sectional approach, used to analyze the relationship between respondent characteristics, risk factors, and the incidence of dental caries at the same point in time. The study was conducted at SMP Negeri 1 Tanjung Lubuk, located within the working area of Pengarayan Public Health Center, Ogan Komering Ilir Regency, in 2026. The study population comprised all students in grades VII, VIII, and IX of SMP Negeri 1 Tanjung Lubuk, totaling 96 students, consisting of 34 seventh-grade students, 30 eighth-grade students, and 32 ninth-grade students. Because the population size was relatively small, a total sampling technique was used, whereby the entire population served as respondents, amounting to 96 students.

Respondents included in the study met the inclusion criteria: active students in grades VII, VIII, and IX during the 2026 academic year, present at the time of the study, willing to participate as respondents, and having obtained written consent from a parent or guardian. The exclusion criteria included students who were absent at the time of the study, ill or otherwise unable to undergo dental examination, unwilling to participate as respondents, lacking parental or guardian consent, or undergoing intensive dental treatment.

The dependent variable in this study was the incidence of dental caries, while the independent variables included age, sex, consumption of cariogenic foods, oral hygiene, fluoride use, and socioeconomic status. Primary data were obtained through interviews using a structured questionnaire, observation, and dental health examinations using a dental examination sheet. Secondary data were obtained from routine oral and dental health service reports and dental caries incidence data from the working area of Pengarayan Public Health Center.

Data Analysis

Collected data were processed through the stages of editing, coding, data entry, cleaning, and data presentation before being analyzed using the Statistical Package for the Social Sciences (SPSS) software. Univariate analysis was performed to describe the frequency distribution and percentages of respondent characteristics and all study variables.

Bivariate analysis was subsequently conducted using the Chi-square test at a 95% confidence level ($\alpha = 0.05$) to determine the associations between age, sex, consumption of cariogenic foods, oral hygiene, fluoride use, and socioeconomic status with the incidence of dental caries. The results of the analysis are presented as p-values, Odds Ratios (OR), and 95% Confidence Intervals (95% CI). When the assumptions of the Chi-square test were not met, Fisher's Exact Test was used as an alternative.

Variables with a p-value < 0.25 in the bivariate analysis were subsequently entered into multivariate analysis using multiple logistic regression to identify the most dominant factor associated with the incidence of dental caries among students of SMP Negeri 1 Tanjung Lubuk in the working area of Pengarayan Public Health Center, Ogan Komering Ilir Regency, in 2026. The results of the multivariate analysis are presented as Adjusted Odds Ratios (AOR), 95% Confidence Intervals (95% CI), and significance values of $p < 0.05$.

Result and Discussion

This study involved 96 respondents, comprising all students in grades VII, VIII, and IX of SMP Negeri 1 Tanjung Lubuk in the working area of Pengarayan Public Health Center, Ogan Komering Ilir Regency, in 2026. Data analysis was conducted in stages, consisting of univariate analysis to describe respondent characteristics and the frequency distribution of dental caries incidence and all study variables; bivariate analysis using the Chi-square test to determine the associations between age, sex, consumption of cariogenic foods, oral hygiene, fluoride use, and socioeconomic status with the incidence of dental caries; and multivariate analysis using multiple logistic regression to identify the most dominant factor associated with the incidence of dental caries among students of SMP Negeri 1 Tanjung Lubuk in the working area of Pengarayan Public Health Center, Ogan Komering Ilir Regency, in 2026. The results of the analysis are presented as follows.

Univariate Analysis

Univariate analysis was used to describe respondent characteristics and the distribution of each study variable descriptively. Respondent characteristics in this study included age and sex. The independent variables examined consisted of cariogenic food consumption, oral hygiene, fluoride use, and socioeconomic status, while the dependent variable was the incidence of dental caries among students of SMP Negeri 1 Tanjung Lubuk in the working area of Pengarayan Public Health Center, Ogan Komering Ilir Regency, in 2026. The results of the univariate analysis are presented in frequency distribution and percentage tables to provide a general overview of respondent characteristics and the distribution of each study variable.

Frequency Distribution of Respondents by Age

The frequency distribution of respondents by age at Pengarayan Public Health Center, OKI Regency, 2026, is presented in the following table:

Table 1. Frequency Distribution of Respondents by Age at Pengarayan Public Health Center, OKI Regency, 2026

No	Age Category	n (N=96)	Percentage (%)
1	Children	2	2.1%
2	Adolescents	94	97.9%
	Total	96	100%

Based on Table 1, it is shown that the majority of respondents fell into the adolescent category, namely 94 respondents (97.9%), while only 2 respondents (2.1%) fell into the children category. This indicates that the majority of student respondents were in early adolescence, consistent with the characteristics of junior high school students. During adolescence, changes in behavior and dietary patterns occur that may increase the risk of dental caries, such as increased consumption of sweet foods and suboptimal oral hygiene behavior.

Frequency Distribution of Respondents by Sex

The frequency distribution of respondents by sex at Pengarayan Public Health Center, OKI Regency, 2026, is presented in the following table:

Table 2. Frequency Distribution of Respondents by Sex at Pengarayan Public Health Center, OKI Regency, 2026

No	Sex	n (N=96)	Percentage (%)
1	Male	52	54.4%
2	Female	44	45.8%
	Total	96	100%

Based on Table 2, the majority of respondents were male, totaling 52 respondents (54.4%), while female respondents totaled 44 (45.8%). These results indicate that the sex distribution of respondents was relatively balanced, although the number of males was slightly higher than females. Sex differences in this study may influence oral and dental health behavior as well as dietary patterns associated with the incidence of dental caries.

Frequency Distribution of Respondents by Grade Level

The frequency distribution of respondents by grade level at Pengarayan Public Health Center, OKI Regency, 2026, is presented in the following table:

Table 3. Frequency Distribution of Respondents by Grade Level at Pengarayan Public Health Center, OKI Regency, 2026

No	Grade	n (N=96)	Percentage (%)
1	IX	32	33.3%
2	VII	34	35.4%
3	VIII	30	31.3%
	Total	96	100%

Based on Table 3, the majority of respondents were from grade VII, totaling 34 respondents (35.4%), followed by grade IX with 32 respondents (33.3%), and grade VIII with 30 respondents (31.3%). These results indicate that the distribution of respondents by grade level was relatively even. Differences in grade level may be related to differences in age, knowledge level, and oral and dental health behavior among students.

Frequency Distribution of Respondents by Cariogenic Food Consumption

The frequency distribution of respondents by cariogenic food consumption at Pengarayan Public Health Center, OKI Regency, 2026, is presented in the following table:

Table 4. Frequency Distribution of Respondents by Cariogenic Food Consumption at Pengarayan Public Health Center, OKI Regency, 2026

No	Cariogenic Food Consumption	n (N=96)	Percentage (%)
1	Infrequent	46	47.9%
2	Frequent	50	52.1%
	Total	96	100%

Based on Table 4, respondents who infrequently consumed cariogenic foods numbered 46 (47.9%), while those who frequently consumed cariogenic foods numbered 50 (52.1%). This indicates that the distribution of cariogenic food consumption among respondents leaned toward frequent consumption. Excessive consumption of high-sugar and sticky foods can accelerate the demineralization of tooth enamel, thereby triggering the occurrence of caries.

Frequency Distribution of Respondents by Oral Hygiene (Toothbrushing Behavior)

The frequency distribution of respondents by oral hygiene (toothbrushing behavior) at Pengarayan Public Health Center, OKI Regency, 2026, is presented in the following table:

Table 5. Frequency Distribution of Respondents by Oral Hygiene (Toothbrushing Behavior) at Pengarayan Public Health Center, OKI Regency, 2026

No	Oral Hygiene (Toothbrushing Behavior)	n (N=96)	Percentage (%)
1	Good	56	58.3%
2	Poor	40	41.7%
	Total	96	100%

Based on Table 5, the majority of respondents had good oral hygiene, totaling 56 respondents (58.3%), while respondents with poor oral hygiene numbered 40 (41.7%). These results indicate that most students already practiced adequate dental hygiene maintenance behavior; however, respondents with poor dental hygiene remain present and may potentially increase the risk of dental caries.

Frequency Distribution of Respondents by Fluoride Use

The frequency distribution of respondents by fluoride use at Pengarayan Public Health Center, OKI Regency, 2026, is presented in the following table:

Table 6. Frequency Distribution of Respondents by Fluoride Use at Pengarayan Public Health Center, OKI Regency, 2026

No	Fluoride Use	n (N=96)	Percentage (%)
1	Uses fluoride	46	47.9%
2	Does not use fluoride	50	52.1%
	Total	96	100%

Based on Table 6, respondents who used fluoride numbered 46 (47.9%), while those who did not use fluoride numbered 50 (52.1%). These results indicate that fluoride use among respondents remains suboptimal, as less than half of respondents used fluoride. Fluoride plays an important role in strengthening tooth enamel resistance and supporting the remineralization process, thereby helping to prevent the occurrence of dental caries.

Frequency Distribution of Respondents by Socioeconomic Status

The frequency distribution of respondents by socioeconomic status at Pengarayan Public Health Center, OKI Regency, 2026, is presented in the following table:

Table 7. Frequency Distribution of Respondents by Socioeconomic Status at Pengarayan Public Health Center, OKI Regency, 2026

No	Socioeconomic Status	n (N=96)	Percentage (%)
1	Above the Regional Minimum Wage (UMK)	42	43.8%
2	Below the Regional Minimum Wage (UMK)	54	56.3%
	Total	96	100%

Based on Table 7, the majority of respondents came from families with income below the regional minimum wage (UMK), totaling 54 respondents (56.3%), while respondents with family income above the UMK numbered 42 (43.8%). This indicates that the majority of respondents came from families of lower-middle economic status. Socioeconomic conditions may influence a family's capacity to meet health-related needs, including access to dental health services, use of fluoride toothpaste, and the provision of nutritious food.

Frequency Distribution of Dental Caries Incidence

The frequency distribution of dental caries incidence at Pengarayan Public Health Center, OKI Regency, 2026, is presented in the following table:

Table 8. Frequency Distribution of Dental Caries Incidence at Pengarayan Public Health Center, OKI Regency, 2026

No	Caries Status	n (N=96)	Percentage (%)
1	No caries	53	55.2%
2	Caries present	43	44.8%
	Total	96	100%

Based on Table 8, the majority of respondents did not have dental caries, totaling 53 respondents (55.2%), while respondents with dental caries numbered 43 (44.8%). These results

indicate that the incidence of dental caries among students remains relatively high, as nearly half of the respondents had dental caries. This condition suggests that oral and dental health problems remain an important concern among school students.

Bivariate Analysis

Bivariate analysis was conducted to determine the association between the independent variables and the dependent variable, namely the incidence of dental caries among students of SMP Negeri 1 Tanjung Lubuk in the working area of Pengarayan Public Health Center, Ogan Komering Ilir Regency, in 2026. The independent variables analyzed included age, sex, consumption of cariogenic foods, oral hygiene, fluoride use, and socioeconomic status. The association between variables was analyzed using the Chi-square test at a 95% confidence level ($\alpha = 0.05$). When cell requirements for the Chi-square test were not met—that is, when the expected count was less than 5—Fisher's Exact Test was used as an alternative. The results of the bivariate analysis were used to determine whether a significant association existed between each independent variable and the incidence of dental caries.

Association Between Age and the Incidence of Dental Caries

Table 9. Association Between Age and the Incidence of Dental Caries at Pengarayan Public Health Center, OKI Regency, 2026

No	Age	No Caries n (%)	Caries Present n (%)	Total n (%)	PR (95% CI)	p-value
1	Children	2 (100%)	0 (0%)	2 (100%)	1.843	0.500
2	Adolescents	51 (54.3%)	43 (45.7%)	94 (100%)	(1.531–2.219)	

Based on Table 9, the results of the bivariate analysis between age and the incidence of dental caries show that in the children category, 100% (2 respondents) had no dental caries compared with 0% (0 respondents) who had caries, while in the adolescent category, 54.3% (51 respondents) had no dental caries compared with 45.7% (43 respondents) who had caries. Descriptively, the incidence of dental caries was more frequently found among adolescents than among children, although the difference was not substantial. The statistical test results showed a PR of 1.843 (95% CI: 1.531–2.219) with a p-value of 0.500 (>0.05), indicating no significant association between age and the incidence of dental caries among students of SMP Negeri 1 Tanjung Lubuk in 2026. This suggests that age was not a factor significantly associated with the incidence of dental caries among the study respondents.

Association Between Sex and the Incidence of Dental Caries

Table 10. Association Between Sex and the Incidence of Dental Caries at Pengarayan Public Health Center, OKI Regency, 2026

No	Sex	No Caries n (%)	Caries Present n (%)	Total n (%)	PR (95% CI)	p-value
1	Male	29 (55.8%)	23 (44.2%)	52 (100%)	1.022	1.000
2	Female	24 (54.5%)	20 (45.5%)	44 (100%)	(0.469–2.355)	

Based on Table 10, the results of the bivariate analysis between sex and the incidence of dental caries show that among males, 55.8% (29 respondents) had no dental caries compared with 44.2% (23 respondents) who had caries, while among females, 54.5% (24 respondents) had no dental caries compared with 45.5% (20 respondents) who had caries. Descriptively, the proportion of dental caries incidence was relatively similar between males and females, showing no meaningful difference. The statistical test results showed a PR of 1.022 (95% CI: 0.469–2.355) with a p-value of 1.000 (>0.05), indicating no significant association between

sex and the incidence of dental caries. This suggests that both males and females had a relatively similar risk of developing dental caries.

Association Between Cariogenic Food Consumption and the Incidence of Dental Caries

Table 11. Association Between Cariogenic Food Consumption and the Incidence of Dental Caries at Pengarayan Public Health Center, OKI Regency, 2026

No	Cariogenic Food Consumption	No Caries n (%)	Caries Present n (%)	Total n (%)	PR (95% CI)	p-value
1	Infrequent	15 (32.6%)	31 (67.4%)	46 (100%)	0.429	0.001
2	Frequent	38 (76%)	12 (24%)	50 (100%)	(0.275–0.669)	

Based on Table 11, the results of the bivariate analysis between cariogenic food consumption and the incidence of dental caries show that among children who infrequently consumed cariogenic foods, 32.6% (15 respondents) had no dental caries compared with 67.4% (31 respondents) who had caries, while among children who frequently consumed cariogenic foods, 76% (38 respondents) had no dental caries compared with 24% (12 respondents) who had caries. Descriptively, children who frequently consumed cariogenic foods showed a higher tendency to develop dental caries than those who consumed such foods infrequently. The statistical test results showed a PR of 0.429 (95% CI: 0.275–0.669) with a p-value of 0.001 (<0.05), indicating a significant association between cariogenic food consumption and the incidence of dental caries among students. Continuous consumption of high-sugar foods may increase bacterial activity in producing acids that cause demineralization of tooth enamel and trigger the formation of caries.

Association Between Oral Hygiene and the Incidence of Dental Caries

Table 12. Association Between Oral Hygiene and the Incidence of Dental Caries at Pengarayan Public Health Center, OKI Regency, 2026

No	Oral Hygiene (Toothbrushing Behavior)	No Caries n (%)	Caries Present n (%)	Total n (%)	PR (95% CI)	p-value
1	Good	48 (85.7%)	8 (14.3%)	56 (100%)	6.857	0.001
2	Poor	5 (12.5%)	35 (87.5%)	40 (100%)	(2.999–15.676)	

Based on Table 12, the results of the bivariate analysis between oral hygiene and the incidence of dental caries show that among children with good toothbrushing behavior, 85.7% (48 respondents) had no dental caries compared with 14.3% (8 respondents) who had caries, while among children with poor toothbrushing behavior, 12.5% (5 respondents) had no dental caries compared with 87.5% (35 respondents) who had caries. Descriptively, children with poor toothbrushing behavior experienced dental caries more frequently than children with good toothbrushing behavior. The statistical test results showed a PR of 6.857 (95% CI: 2.999–15.676) with a p-value of 0.001 (<0.05), indicating a significant association between oral hygiene (toothbrushing behavior) and the incidence of dental caries. Respondents with poor oral and dental hygiene had a greater risk of developing dental caries than respondents with good oral hygiene.

Association Between Fluoride Use and the Incidence of Dental Caries

Table 13. Association Between Fluoride Use and the Incidence of Dental Caries at Pengarayan Public Health Center, OKI Regency, 2026

No	Fluoride Use	No Caries n (%)	Caries Present n (%)	Total n (%)	PR (95% CI)	p-value
1	Uses fluoride	13 (28.3%)	33 (71.7%)	46 (100%)	0.353	0.001
2	Does not use fluoride	40 (80%)	10 (20%)	50 (100%)	(0.218–0.571)	

Based on Table 13, the results of the bivariate analysis between fluoride use and the incidence of dental caries show that among children who used fluoride, 28.3% (13 respondents) had no dental caries compared with 71.7% (33 respondents) who had caries, while among children who did not use fluoride, 80% (40 respondents) had no dental caries compared with 20% (10 respondents) who had caries. Descriptively, there was a difference in the proportion of dental caries incidence between children who used fluoride and those who did not. The statistical test results showed a PR of 0.353 (95% CI: 0.218–0.571) with a p-value of 0.001 (<0.05), indicating a significant association between fluoride use and the incidence of dental caries. Fluoride plays a role in strengthening tooth enamel and supporting the remineralization process, thereby reducing the risk of dental caries.

Association Between Socioeconomic Status and the Incidence of Dental Caries

Table 14. Association Between Socioeconomic Status and the Incidence of Dental Caries at Pengarayan Public Health Center, OKI Regency, 2026

No	Socioeconomic Status	No Caries n (%)	Caries Present n (%)	Total n (%)	PR (95% CI)	p-value
1	Above the UMK	24 (57.1%)	18 (42.9%)	42 (100%)	1.064	0.897
2	Below the UMK	29 (53.7%)	25 (46.3%)	54 (100%)	(0.742–1.526)	

Based on Table 14, the results of the bivariate analysis between socioeconomic status and the incidence of dental caries show that among respondents with socioeconomic status above the regional minimum wage (UMK), 57.1% (24 respondents) had no dental caries compared with 42.9% (18 respondents) who had caries, while among respondents with socioeconomic status below the UMK, 53.7% (29 respondents) had no dental caries compared with 46.3% (25 respondents) who had caries. Descriptively, children with socioeconomic status below the UMK showed a slightly higher proportion of dental caries incidence than those above the UMK, although the difference was not substantial. The statistical test results showed a PR of 1.064 (95% CI: 0.742–1.526) with a p-value of 0.897 (>0.05), indicating no significant association between socioeconomic status and the incidence of dental caries among students of SMP Negeri 1 Tanjung Lubuk in 2026.

Multivariate Analysis

Multivariate analysis was conducted to determine the most dominant variable associated with the incidence of dental caries among students of SMP Negeri 1 Tanjung Lubuk in the working area of Pengarayan Public Health Center, Ogan Komering Ilir Regency, in 2026. This analysis was performed using multiple logistic regression, incorporating variables that met the criteria as model candidates based on the results of the bivariate analysis. The modeling process was carried out in stages until the best final model explaining the association between the

independent variables and the incidence of dental caries was obtained. The results of the multiple logistic regression analysis for the initial and final models are presented in the following tables.

Table 15. Results of the Initial Multiple Logistic Regression Model of Factors Associated with the Incidence of Dental Caries at Pengarayan Public Health Center, OKI Regency, 2026

No	Variable	p-value	OR
1	Cariogenic food consumption	0.836	1.162
2	Fluoride use	0.001	0.142
3	Oral hygiene	0.006	38.454

The results in Table 15 regarding the change in OR value after the cariogenic food consumption variable was removed can be seen in the table below:

Table 16. Change in OR After the Cariogenic Food Consumption Variable Was Removed

No	Variable	OR (cariogenic variable retained)	OR (cariogenic variable removed)	Change in OR
1	Cariogenic food consumption	1.162	—	—
2	Fluoride use	0.142	0.151	6.3%
3	Oral hygiene	38.454	36.340	5.4%

Based on the results shown in Table 16, after the cariogenic food consumption variable was removed, the change in OR value was < 10%; therefore, the cariogenic food consumption variable was excluded from the model. The variable with the next largest p-value was fluoride use, with results as follows:

Table 17. Change in OR After the Fluoride Use Variable Was Removed

No	Variable	OR (fluoride variable retained)	OR (fluoride variable removed)	Change in OR
1	Fluoride use	0.151	—	—
2	Oral hygiene	36.340	42.000	15.5%

Based on the results shown in Table 17, after the fluoride use variable was removed, the change in OR value was > 10%; therefore, the fluoride use variable was reintroduced into the model.

Table 18. Omnibus Test of Model Coefficients Block 1: Method = Enter

No		Chi-square	p-value
1	Step	63.335	0.001
2	Block	63.335	0.001
3	Model	63.335	0.001

The results of the omnibus test for Block 1 (Method = Enter) showed a p-value of 0.001 (see the "Step" row), which is < 0.05, indicating that a significant relationship exists between oral hygiene (toothbrushing behavior) and the factors associated with the incidence of dental caries at Pengarayan Public Health Center, OKI Regency, in 2026.

Table 19. Results of the Multivariate Analysis of All Independent Variables

No	Variable	p-value	OR	95% CI for EXP(B) Lower	95% CI for EXP(B) Upper
1	Step 1a — Oral hygiene	0.000	42.000	12.659	139.344

2	Constant	-1.792			
---	----------	--------	--	--	--

The final results of the multivariate analysis showed that the most dominant variable among the factors associated with the incidence of dental caries at Pengarayan Public Health Center, OKI Regency, in 2026, was oral hygiene (toothbrushing behavior) (p-value = 0.001). The results of the multivariate analysis indicate that when the independent variables were tested simultaneously, oral hygiene (toothbrushing behavior) was the most dominant variable associated with the factors related to the incidence of dental caries at Pengarayan Public Health Center, OKI Regency, in 2026.

Table 20. Results of the Multiple Logistic Regression Analysis

No	Variable	B	p-value	OR
1	Oral hygiene	3.738	0.001	42.000
2	Constant	-1.792		

Estimated Probability of Dental Caries

Probability formula:

If Oral Hygiene is Good (X = 0)

$$P = 1 : [1 + e^{-(-1.792 + 3.738X)}]$$

$$P = 1 : [1 + e^{-(-1.792)}]$$

$$P = 0.143$$

$$P = 14.3\%$$

This indicates that respondents with good oral hygiene had a 14.3% probability of developing dental caries.

If Oral Hygiene is Poor (X = 1)

$$P = 1 : [1 + e^{-(-1.792 + 3.738)}]$$

$$P = 1 : [1 + e^{-(-1.946)}]$$

$$P = 0.875$$

$$P = 87.5\%$$

This indicates that respondents with poor oral hygiene had an 87.5% probability of developing dental caries.

Oral Hygiene and Dental Caries

Oral hygiene was the most strongly associated factor with dental caries among students at SMP Negeri 1 Tanjung Lubuk. The final logistic regression model showed that students with poor toothbrushing behavior had substantially higher odds of dental caries than those with good oral hygiene (OR = 42.000). This finding is consistent with Brusius et al. (2023), whose longitudinal study identified toothbrushing frequency as an important factor in caries development among adolescents. Bramantoro et al. (2021) also found that school-based oral health promotion programs improved oral hygiene knowledge, behavior, and selected clinical outcomes, particularly when teachers and parents were involved. Similarly, Tavakoli et al. (2025) reported that supervised toothbrushing interventions could contribute to caries prevention, although their effectiveness varied according to the clinical outcome measured. These studies support the importance of regular toothbrushing, but also indicate that brushing frequency alone does not fully represent oral hygiene quality. Proper technique, consistency, and fluoride exposure remain relevant considerations.

The strong relationship between oral hygiene and dental caries also highlights the importance of preventive behavior during adolescence. Akera et al. (2022) demonstrated that school-based interventions combining practical education, preventive services, and parental engagement

improved several oral health outcomes in low- and middle-income countries, although the certainty of evidence was limited. Dadipoor et al. (2023) similarly identified improvements in oral health knowledge and behavior following educational interventions. Kim and Kim (2024) further reported positive effects of school-based oral health education on oral hygiene and gingival health. Nevertheless, the relatively large odds ratio in the present study should be interpreted cautiously because of the limited sample size and the wide confidence interval. Wang et al. (2025) emphasized that dental caries prediction models frequently face methodological limitations, including inadequate statistical procedures and insufficient validation. Thus, oral hygiene represents an important associated factor in this study, although the magnitude of its association should not be interpreted as a causal effect.

Cariogenic Food Consumption and Fluoride Use

The associations involving cariogenic food consumption and fluoride use require careful interpretation because their observed directions differ from established preventive evidence. Students reporting infrequent cariogenic food consumption had a higher prevalence of caries than frequent consumers. This contrasts with Moores et al. (2022), whose systematic review supported an association between sugar intake and dental caries. Differences in the measurement of dietary exposure may help explain this inconsistency. Current consumption habits may not adequately reflect prolonged sugar exposure, particularly when students have already changed their dietary practices because of dental problems. The present study therefore cannot establish whether reported dietary behavior preceded caries development, and its findings should not be interpreted as evidence that frequent consumption of cariogenic foods is protective.

The fluoride results require similar caution, as dental caries was more common among students reporting fluoride use. This association differs from the established preventive role of fluoride. Iheozor-Ejiofor et al. (2024), in a Cochrane systematic review, evaluated the effectiveness of water fluoridation in preventing dental caries, while Almalki et al. (2025) reported preventive benefits from fluoride varnish interventions delivered in educational settings. James et al. (2025) also emphasized the role of early detection and preventive dental interventions in controlling caries progression. However, fluoride exposure in the present study was classified only according to reported use, without distinguishing the product, concentration, application frequency, or duration of exposure. Students with existing caries may also have initiated fluoride use following dental advice. These possibilities suggest that the observed association may reflect differences in exposure measurement or reverse causation rather than a harmful effect of fluoride.

Demographic and Socioeconomic Factors Associated with Dental Caries

Age and sex were not significantly associated with dental caries in the present study. This finding should be considered in relation to the relatively homogeneous characteristics of the respondents, most of whom were adolescents attending the same school. Dai et al. (2025) demonstrated that the burden of oral disorders among adolescents and young adults varies across populations and socioeconomic development levels, indicating that dental health patterns are influenced by broader contextual conditions. Similarly, Hasan et al. (2024), through a systematic review and meta-analysis of Indonesian children, documented substantial variation in dental caries prevalence across observational studies. Differences in age distribution, clinical assessment, and population characteristics may contribute to this variation. The limited representation of children in the present sample reduces the reliability of comparisons between age categories, while the absence of a significant sex association does not exclude possible differences in oral health behavior between male and female students.

Socioeconomic status was also not significantly associated with dental caries, although previous studies have identified socioeconomic inequality as an important determinant of oral

health. Brondani et al. (2024), through a 10-year cohort study, demonstrated that childhood socioeconomic disadvantage contributed to untreated dental caries during adolescence. Vukovic et al. (2025) similarly identified significant differences in dental caries across European countries according to socioeconomic and geographical conditions. These findings suggest that socioeconomic disadvantage may influence oral health through cumulative exposure and unequal access to preventive care. Hidalgo-Mora et al. (2024) further examined the association between parental oral health literacy and children's oral health, highlighting the importance of family knowledge and health-related practices. In the present study, socioeconomic status was assessed using family income relative to the Regional Minimum Wage, which may not fully capture parental education, healthcare accessibility, and household preventive behavior. Therefore, the nonsignificant association should be interpreted within the limitations of the socioeconomic indicator used.

Implications for School-Based Dental Caries Prevention

The findings suggest that dental caries prevention at SMP Negeri 1 Tanjung Lubuk should prioritize sustainable improvements in oral hygiene while addressing dietary practices and appropriate fluoride use. Elsadek et al. (2023) found that peer-led oral health interventions could improve students' oral health knowledge and selected behavioral and clinical outcomes, indicating that student participation may strengthen preventive activities. Bhadauria et al. (2024) also highlighted the benefits of school-based oral health programs, particularly in improving preventive behavior and oral hygiene indicators. Das et al. (2025) similarly emphasized the contribution of structured educational interventions to oral hygiene practices, although evidence concerning long-term reductions in dental caries remains less consistent. These studies support strengthening the School Dental Health Program (UKGS) through practical toothbrushing demonstrations, regular dental examinations, dietary education, and collaboration between schools, parents, and healthcare providers.

Preventive strategies should nevertheless be developed with consideration of the study's methodological limitations. The cross-sectional design cannot establish causal relationships, while self-reported behavior may introduce recall and reporting biases. Moreover, the unexpected patterns involving cariogenic food consumption and fluoride use require further investigation using more detailed behavioral measurements. Future studies should consider longitudinal designs, standardized dental assessments, and broader socioeconomic indicators to better explain the factors associated with dental caries among adolescents. Within the present findings, oral hygiene remains the most prominent associated factor, supporting its prioritization in school-based oral health promotion without excluding the importance of other preventive measures.

Lu et al. (2025) additionally demonstrated that oral disease disparities persist across adolescent populations despite improvements in some dental health indicators. This reinforces the importance of evaluating preventive programs according to their longer-term clinical outcomes and their ability to reach students with different levels of oral health risk.

Conclusion

Based on respondent characteristics, the majority of respondents were in the adolescent age group (97.9%), male (54.4%), with a relatively even distribution across grade levels. Most respondents frequently consumed cariogenic foods (52.1%), had good oral hygiene (58.3%), used fluoride (47.9%), and came from families with socioeconomic status below the regional minimum wage (UMK) (56.3%). Regarding the incidence of dental caries, the majority of respondents (55.2%) had no dental caries, while 44.8% had caries, indicating that dental caries remains an oral health problem among students of SMP Negeri 1 Tanjung Lubuk that requires attention through promotive and preventive efforts. The bivariate analysis showed no significant association between age and the incidence of dental caries, nor between sex and the

incidence of dental caries, among students of SMP Negeri 1 Tanjung Lubuk. In contrast, a significant association was found between cariogenic food consumption and the incidence of dental caries (PR = 0.429), between oral hygiene (toothbrushing behavior) and the incidence of dental caries (PR = 6.857) with respondents exhibiting poor toothbrushing behavior having a greater risk of developing caries than those with good toothbrushing behavior and between fluoride use and the incidence of dental caries (PR = 0.353). No significant association was found between socioeconomic status and the incidence of dental caries among students of SMP Negeri 1 Tanjung Lubuk.

The results of the multivariate analysis showed that oral hygiene (toothbrushing behavior) was the most dominant factor associated with the incidence of dental caries among students of SMP Negeri 1 Tanjung Lubuk (OR = 42.000), indicating that respondents with poor toothbrushing behavior had approximately 42 times greater odds of developing dental caries than respondents with good toothbrushing behavior, after controlling for other variables in the model. These findings collectively demonstrate that the incidence of dental caries among students of SMP Negeri 1 Tanjung Lubuk was more strongly determined by modifiable behavioral factors particularly oral hygiene, cariogenic food consumption, and fluoride use than by demographic or socioeconomic characteristics such as age, sex, and family income level. This underscores the importance of prioritizing behavior-focused interventions, rather than purely demographic targeting, in the design of school-based dental caries prevention programs.

Recommendations

Based on the findings of this study, it is recommended that Pengarayan Public Health Center, Ogan Komering Ilir Regency, strengthen promotive and preventive efforts through reinforcement of the School Dental Health Program (UKGS), education on proper toothbrushing techniques, promotion of fluoride toothpaste use, control of cariogenic food consumption, and regular dental examinations. SMP Negeri 1 Tanjung Lubuk is expected to collaborate with the Public Health Center in enhancing dental health education, fostering consistent dental hygiene habits, and monitoring the consumption of high-sugar foods within the school environment. Students and parents are encouraged to increase awareness of dental health maintenance through regular toothbrushing habits, reduced consumption of cariogenic foods, and routine dental check-ups. Future researchers are advised to employ larger sample sizes, stronger study designs, and additional variables that may potentially influence the incidence of dental caries.

References

- Akera, P., Kennedy, S. E., Lingam, R., Obwolo, M. J., Schutte, A. E., & Richmond, R. (2022). Effectiveness of primary school-based interventions in improving oral health of children in low- and middle-income countries: A systematic review and meta-analysis. *BMC Oral Health*, 22, Article 264. <https://doi.org/10.1186/s12903-022-02291-2>
- Almajed, O. S., Aljouie, A. A., Alharbi, M. S., & Alsulaimi, L. M. (2024). The impact of socioeconomic factors on pediatric oral health: A review. *Cureus*, 16(2), e53567. <https://doi.org/10.7759/cureus.53567>
- Almalki, A. S., Alshahrani, O. S., Aljoaid, F. A., Alrwiali, M. A., Alrais, R. A., Alfuhigi, A. B., Alfahaid, R. A., Daghriri, R. M., Alwably, A. N., Alenazi, G. M., & Alasmari, A. A. (2025). Effectiveness of various fluoride varnishes in preventing dental caries in children and adolescents: A systematic review of evidence from educational settings. *Cureus*, 17(11), e96323. <https://doi.org/10.7759/cureus.96323>
- Astuti, D., Prasetya, R., & Wahyuni, T. (2023). Oral Health Related Quality Of Life Pada Anak Sekolah Dengan Karies Gigi. *Jurnal Kedokteran Gigi Indonesia*, 10(2), 90–98.
- Bhadauria, U. S., Priya, H., Purohit, B., & Singh, A. (2024). Effectiveness of school oral health

- programs in children and adolescents: An umbrella review. *Evidence-Based Dentistry*, 25(4), 211. <https://doi.org/10.1038/s41432-024-01013-7>
- Botelho-Filho, C. R., Bordin, G. M., de Paula, I. C. S. F., Stroparo, J. L. O., Baratto, S. S. P., Caldarelli, P. G., Baratto-Filho, F., Rocha, J. S., & Gabardo, M. C. L. (2025). Impact of dental caries on the quality of life of adolescents: A systematic review and meta-analysis. *Revista Brasileira de Epidemiologia*, 28, e250018. <https://doi.org/10.1590/1980-549720250018>
- Bramantoro, T., Santoso, C. M. A., Hariyani, N., Setyowati, D., Zulfiana, A. A., Mohd Nor, N. A., Nagy, A., Pratamawari, D. N. P., & Irmalia, W. R. (2021). Effectiveness of the school-based oral health promotion programmes from preschool to high school: A systematic review. *PLOS ONE*, 16(8), e0256007. <https://doi.org/10.1371/journal.pone.0256007>
- Brondani, B., Knorst, J. K., Ardenghi, T. M., Mendes, F. M., & Brondani, M. A. (2024). Community and individual socioeconomic inequalities and dental caries from childhood to adolescence: A 10-year cohort study. *Community Dentistry and Oral Epidemiology*, 52(4), 540–549. <https://doi.org/10.1111/cdoe.12950>
- Brusius, C. D., Alves, L. S., & Maltz, M. (2023). Association between toothbrushing frequency and dental caries and tooth loss in adolescents: A cohort study. *Brazilian Oral Research*, 37, e127. <https://doi.org/10.1590/1807-3107bor-2023.vol37.0127>
- Cascaes, A. M., da Silva, N. R. J., Fernandez, M. D. S., Bomfim, R. A., & Vaz, J. D. S. (2023). Ultra-processed food consumption and dental caries in children and adolescents: A systematic review and meta-analysis. *British Journal of Nutrition*, 129(8), 1370–1379. <https://doi.org/10.1017/S0007114522002409>
- Chou, R., Bougatsos, C., Griffin, J., Selph, S. S., Ahmed, A., Fu, R., Nix, C., & Schwarz, E. (2023). Screening, referral, behavioral counseling, and preventive interventions for oral health in children and adolescents aged 5 to 17 years: A systematic review for the US Preventive Services Task Force. *JAMA*, 330(17), 1674–1686. <https://doi.org/10.1001/jama.2023.20435>
- Dadipoor, S., Akbarizadeh, F., Ghaffari, M., Alipour, A., & Safari-Moradabadi, A. (2023). Educational intervention of improve student's oral health: A systematic review and meta-analysis school-based. *Iranian Journal of Public Health*, 52(3), 500–514. <https://doi.org/10.18502/ijph.v52i3.12133>
- Dai, X., Dai, M., Liang, Y., Li, X., & Zhao, W. (2025). Global burden and trends of oral disorders among adolescent and young adult (10–24 years old) from 1990 to 2021. *BMC Oral Health*, 25, Article 486. <https://doi.org/10.1186/s12903-025-05864-z>
- Das, H., Janakiram, C., Kumar, V. S., & Karuveetil, V. (2025). Effectiveness of school-based oral health education interventions on oral health status and oral hygiene behaviors among schoolchildren: An umbrella review. *Evidence-Based Dentistry*, 26(2), 110–111. <https://doi.org/10.1038/s41432-024-01101-8>
- Dewi, A. M. P. D. P., Pamungkasari, E. P., & Murti, B. (2024). The impact of sugar intake, household income, and maternal education on the occurrence of dental caries in children: A meta-analysis. *Journal of Epidemiology and Public Health*, 9(2), 227–242. <https://doi.org/10.26911/jepublichealth.2024.09.02.09>
- Dhanapriyanka, M., Kosgallana, S., Kanthi, R. D. F. C., Jayasekara, P., Dao, T. M. A., Ha, D. H., & Do, L. (2024). Professionally applied fluorides for preventing and arresting dental caries in low- and middle-income countries: Systematic review. *Journal of Public Health Dentistry*, 84(2), 213–227. <https://doi.org/10.1111/jphd.12617>

- Elsadek, Y. E., Edwebi, S., Turner, A., Vinall-Collier, K., Csikar, J., & Pavitt, S. (2023). A systematic review of school-based student peer-led oral health interventions to promote the oral health of school children. *BMC Oral Health*, 23, Article 742. <https://doi.org/10.1186/s12903-023-03482-1>
- Fadila, W., Rahardja, M. B., Prasetyoputra, P., Suwargiani, A. A., Prasetyo, Y. E., & Riyanti, E. (2024). Family's socioeconomic and demographic factors on elements of children's dental and oral health: A scoping review. *Clinical and Experimental Dental Research*. <https://doi.org/10.1002/cre2.818>
- Ghasemi, H., Alautry, H. F., Khoshnevisan, M. H., & Namdari, M. (2025). Effectiveness of a school-based oral health promotion program on dental caries among Iraqi school children: A cluster randomised controlled trial. *International Dental Journal*, 75(2), 744–751. <https://doi.org/10.1016/j.identj.2024.07.1214>
- Hasan, F., Yuliana, L. T., Budi, H. S., Ramasamy, R., Ambiya, Z. I., & Ghaisani, A. M. (2024). Prevalence of dental caries among children in Indonesia: A systematic review and meta-analysis of observational studies. *Heliyon*, 10(11), e32102. <https://doi.org/10.1016/j.heliyon.2024.e32102>
- Hidalgo-Mora, E., Campos-Campos, K. J., Aguilar Gálvez, D., López-Ramos, R. P., & Alvarez Vidigal, E. (2024). Alfabetización en salud bucal de los padres y su asociación con la salud bucal de sus hijos: Una revisión. *Revista Científica Odontológica*, 12(3), e209. <https://doi.org/10.21142/2523-2754-1203-2024-209>
- Hidayat, A., Santoso, W., & Nurhayati, E. (2022). Academic Performance And Dental Caries In Indonesian School Children. *International Journal Of Pediatric Dentistry*, 32(4), 543–550.
- Iheozor-Ejiofor, Z., Walsh, T., Lewis, S. R., Riley, P., Boyers, D., Clarkson, J. E., Worthington, H. V., Glenny, A.-M., & O'Malley, L. (2024). Water fluoridation for the prevention of dental caries. *Cochrane Database of Systematic Reviews*, 2024(10), CD010856. <https://doi.org/10.1002/14651858.CD010856.pub3>
- James, Y., Nadeem, A., & Carpenter, F. (2025). Role of the early detection and prevention of dental caries in children: A systematic review of clinical outcomes. *Cureus*, 17(6), e85185. <https://doi.org/10.7759/cureus.85185>
- Kementerian Kesehatan Republik Indonesia. (2024). *Profil Kesehatan Indonesia Tahun 2024*. Jakarta: Kementerian Kesehatan RI.
- Kim, S., & Kim, S. Y. (2024). Effectiveness of school-based oral health education for children and adolescents in low- and middle-income countries: A systematic review and meta-analysis. *Asia-Pacific Journal of Public Health*, 36(4), 312–321. <https://doi.org/10.1177/10105395241240959>
- Large, J. F., Madigan, C., Pradeilles, R., Markey, O., Boxer, B., & Rousham, E. K. (2024). Impact of unhealthy food and beverage consumption on children's risk of dental caries: A systematic review. *Nutrition Reviews*, 82(11), 1539–1555. <https://doi.org/10.1093/nutrit/nuad147>
- Lu, W., Wang, B., Du, M., & Ge, S. (2025). Global burden of oral diseases in adolescents and young adults aged 10–24 years. *International Dental Journal*, 75(4), Article 100875. <https://doi.org/10.1016/j.identj.2025.100875>
- Luo, B. W., Liang, N. L., Townsend, J. A., Lo, E. C. M., Chu, C. H., & Duangthip, D. (2024). Sugar substitutes on caries prevention in permanent teeth among children and adolescents: A systematic review and meta-analysis. *Journal of Dentistry*, 146,

- Mazur, M., Corridore, D., Ndokaj, A., Ardan, R., Vozza, I., Babajko, S., & Jedeon, K. (2023). MIH and dental caries in children: A systematic review and meta-analysis. *Healthcare*, 11(12), 1795. <https://doi.org/10.3390/healthcare11121795>
- Moore, C. J., Kelly, S. A. M., & Moynihan, P. J. (2022). Systematic review of the effect on caries of sugars intake: Ten-year update. *Journal of Dental Research*, 101(9), 1034–1045. <https://doi.org/10.1177/00220345221082918>
- Nath, S., Sethi, S., Bastos, J. L., Constante, H. M., Mejia, G., Haag, D., Kapellas, K., & Jamieson, L. (2023). The global prevalence and severity of dental caries among racially minoritized children: A systematic review and meta-analysis. *Caries Research*, 57(4), 485–508. <https://doi.org/10.1159/000533565>
- Pombo-Lopes, J., Silva, M. L., Neves, B., & Grillo-Evangelista, J. (2026). Impact of sugar consumption on dental caries in children and adolescents: A systematic review of frequency versus quantity. *BMC Public Health*. Advance online publication. <https://doi.org/10.1186/s12889-026-27780-9>
- Sabbagh, S., Mohammadi-Nasrabadi, F., Ravaghi, V., Mood, K. A., Shirazi, A. S., Abedi, A.-S., & Noorollahian, H. (2023). Food insecurity and dental caries prevalence in children and adolescents: A systematic review and meta-analysis. *International Journal of Paediatric Dentistry*, 33(4), 346–363. <https://doi.org/10.1111/ipd.13041>
- Sainuddin, Angki, J., S, R., & Bahtiar. (2023). Factors causing dental caries in elementary school students. *Media Kesehatan Gigi: Politeknik Kesehatan Makassar*, 22(1), 53–60. <https://doi.org/10.32382/mkg.v22i1.26>
- Tavakoli, S., Saadatfar, N., & Tiyyuri, A. (2025). The effectiveness of school-based supervised tooth brushing intervention for preventing dental caries: A systematic review and meta-analysis. *BMC Oral Health*, 25, Article 1967. <https://doi.org/10.1186/s12903-025-07299-y>
- Vukovic, A., Schmutz, K. A., Borg-Bartolo, R., Cocco, F., Rosianu, R. S., Jorda, R., MacLennan, A., Cortes-Martinicorena, J. F., Rahiotis, C., Madléna, M., Arghittu, A., Dettori, M., Castiglia, P., Esteves-Oliveira, M., Cagetti, M. G., Wolf, T. G., & Campus, G. (2025). Caries status in 12-year-old children, geographical location and socioeconomic conditions across European countries: A systematic review and meta-analysis. *International Journal of Paediatric Dentistry*, 35(1), 201–215. <https://doi.org/10.1111/ipd.13224>
- Wahyuni, S., Nurhayati, M. N., & Septiana, R. S. (2023). Korelasi Status Sosial Ekonomi Terhadap Kejadian Karies Gigi Anak TK Bina Putra II Sukrame Palembang. *Jurnal Kesehatan Gigi dan Mulut (JKGM)*, 5(1), 14–22.
- Wang, X., Zhang, P., Lu, H., Luo, D., Yang, D., Li, K., Qiu, S., Zeng, H., & Zeng, X. (2025). Risk prediction models for dental caries in children and adolescents: A systematic review and meta-analysis. *BMJ Open*, 15(3), e088253. <https://doi.org/10.1136/bmjopen-2024-088253>
- Widyastuti, N., & Wahyudadi, B. S. (2024). Risiko Karies Gigi Dari Konsumsi Makanan Kariogenik Pada Anak Sekolah Dasar. *Media Kesehatan Gigi: Politeknik Kesehatan Makassar*, 23(2), 38–42.
- World Health Organization (WHO). (2022). *Global Oral Health Status Report: Towards Universal Health Coverage For Oral Health By 2030*. Geneva: World Health Organization.